
Improving Safety for Elders and Disabled: Smart Homes and Assisted Living

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Abstract: Care of the elderly and the disabled poses a big challenge for the subject, families, caregivers, hospitals, nursing homes, and society as a whole. A coordinated and multidisciplinary team is required to help this vulnerable population. Smart homes, wearable sensors, and assisted living concept promise a great help in care of the elderly and the disabled.

Keywords: Smart home, care of old, care of elderly, care of disabled, assisted living, care of ageing population, home automation, intelligent homes.

1. Introduction

Safety and well-being in vulnerable population like elderly with disabling comorbidities like rheumatoid arthritis, osteoarthritis, cardiovascular diseases; neurological illnesses like Alzheimer's disease, Parkinson's disease, stroke; and mentally and physically challenged individuals across all age groups has always been a challenge. Considering their vulnerability, the elders may choose to live with their children, or living near to them in a separate home, or may prefer living in a retirement home [1, 2]. Depending on the need, the caregivers devise different methods to take care of the elderly.

Preventing adverse events like falls at homes and outside, safety and security concerns have prompted development of newer devices and methods. Sensors, video monitoring and alarm systems to warn relatives early in case an adverse event occurs- so that help may arrive early- have already gained popularity. In this article we look at some of the available video surveillance devices, embedded systems, and sensor systems that can be very helpful in safety of the vulnerable individuals. We will also look at the concept of assisted living that is slowly gaining popularity in India.

2. Ageing

Ageing results in a number of disabilities resulting from functional deficit (deterioration in balance, power and performance), muscular weakness (muscle atrophy) and weakness of bones (osteoporosis) [3]. Chronic illnesses like dementia,

Parkinson's disease, stroke, chronic respiratory diseases, diabetes, kidney failure, rheumatoid arthritis, osteoarthritis, cardiovascular diseases, and many others also make the elders very vulnerable and in need of dedicated care. Besides this the ageing population may also suffer from physical or emotional abuse or neglect, either intentional or unintentional, from caregivers and/or a person who stands in trust relationship with the elder [4, 5, 6].

3. Major Problems Associated with Ageing

Mentioned below are some of the major problems the ageing population faces.

3.1 Low Bone Density

The elderly population is at high risk of low bone mineral density that increases the risk of fractures. Low threshold for tolerating trauma limits their mobility. Sometimes a very minor trauma, or even without any trauma fractures may occur. Fractures in spine, hip fractures are common and debilitating. The fractures in the elderly are associated with increased risk of death [7, 8].

3.2 Falls

As per WHO, a fall is defined as "inadvertently coming to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects" [10].

Falls are very frequent in the elderly population [10]. Those with Diabetes Mellitus, Parkinson's disease, depression, incontinence, Alzheimer's disease, visual impairment, cognitive impairment, foot problems, alcohol intake, and under effect of some medications are at increased risk of falling. Fall related risk of death increases exponentially in elderly population. [10]

Falls can result in fractures, hospitalization, increased dependence, morbid fear of falling again, immobilization and depression [10].

3.3 Cardiovascular Disease

Cardiovascular disease, cardiac arrhythmias, and cardiac arrest are leading causes of death in the elderly. More than 50% of people over the age of 60 years have significant coronary artery disease, the risk increasing with increasing age [13, 14, 15]. People with cardiovascular disease need special care. In case of cardiac arrest, early cardiopulmonary resuscitation (CPR) can save lives [14]. Hence is a proper surveillance system is in place at home, or assisted living facility, alarms may warn the caregiver early, and an early medical intervention might be possible.

3.4 Dementia

Dementia, usually chronic and progressive in nature, can be caused by a number of illnesses of the brain that affect memory, thought process and behaviour. Ability to perform everyday activities gets impaired [9].

In 2015, number of people living with dementia worldwide was estimated to be 47.5 million. The numbers are expected to increase by 71% by 2050 [9].

Taking care of patients with dementia requires a lot of effort from caregivers. It is a stress and huge commitment. The caregivers need a lot of support to carry on their responsibility [9]. This is where smart home and assisted living concepts come as a boon.

3.5 Stroke

The incidence of stroke increases with age, doubling for each decade after the age of 55 years [16]. Stroke is a dreaded condition. It is number one cause of chronic disability worldwide. It can cause dementia, and is a leading cause of death [16]. Early initiation of medical therapy is of paramount importance in stroke, as it can limit the disability, and decreases mortality. People who come for treatment within 3 hours and receive treatment suffer from less disability, and are at lesser risk of death, as compared to those that come later [17].

3.6 Chronic Rheumatic Conditions

Chronic rheumatic or musculoskeletal conditions comprise of over 150 diseases or syndromes that are usually progressive and associated with pain. Examples include rheumatoid arthritis, osteoarthritis, spinal disorders and severe limb trauma. Osteoarthritis is a degenerative joint disease that is associated with ageing [18].

These diseases cause limitation of mobility, pain, decreased ability to work, and are associated with falls, injuries, and decreased quality of life [19].

3.7 Chronic Respiratory Illnesses

Chronic respiratory illnesses like asthma, chronic obstructive pulmonary disease and bronchiectasis are a major cause of morbidity and mortality in elderly population [20, 21].

3.8 Diabetes and Hypertension

Diabetes and hypertension needs to be managed and monitored meticulously [30]. This may become challenging in the elderly population if suffering from multiple comorbidities like arthritis, stroke, dementia, Parkinson's disease and heart failure, as their mobility is restricted, and they are unable to come for health check as required. Moreover many elders have difficulty complying with advised treatment by doctors [32].

Blood pressure may become uncontrolled leading to brain haemorrhages, heart failure, and sudden death. Similarly uncontrolled blood sugar may prove very dangerous [31].

Very high blood sugar levels can lead to diabetic ketoacidosis that may be life threatening. Low blood sugar levels may cause unconsciousness, fall, and may be dangerous [31].

3.9 Cancer

The risk of cancer increases drastically in elderly population. 60% of newly diagnosed cancers and 70% of all cancer deaths are implicated in people over 65 years of age [12]. The patients with cancer need a lot of care as they can have a number of symptoms based on the type of cancer, like difficulty in breathing, swallowing, urinating, defecating, and movement. There may be cognitive impairment, pain, anxiety and depression.

3.10 Chronic Kidney Disease

Studies have shown an exponential decline in kidney function in elderly population as age advances. Chronic kidney disease (CKD) is associated with increased morbidity and mortality [29].

3.11 Abuse and Neglect

There may be an issue with the safety of the elderly population in their own homes as well. There are numerous documented instances of emotional or physical abuse, or neglect at the hands of a caregiver or a person whom the elder trusts.

This could be intentional or unintentional, but nevertheless raises a serious issue regarding care of these elders [4, 5, 6].

4. Disability

People disabled due to various illnesses, like accidents resulting in amputations, paralysis, stroke in the young, neurological illnesses, deaf and blind and mentally retarded also need special care in the form of family support, social support, caregiver, assisted living, and/or smart homes.

The disabled people are an increased risk of falls, and mortality associated with falls. Poor vision, poor balance, muscle weakness, poor judgement may result in falls. Medications that cause sedation, incoordination, and affect balance may result in increased risk of falls. [11]. Greater care is required to help these people.

5. A few Solutions

5.1 Smart Homes and Wearable Sensors

Smart homes are also known as intelligent homes, sensor embedded houses, home automation, home networking and adaptive homes [22]. These are called smart homes because their lightings, heating, locking doors and windows, electronic devices can be controlled remotely through smartphones or computers by the use of internet and information technology [23]. These houses are installed with sensors and biomedical monitors and allow the residents to program and control various appliances in the house through a central control panel at home, or remotely by the help of remote controls, computers or smartphones. Camera systems, video-based human fall detection systems, movement or activity sensors, foot-pressure change sensors, radiofrequency sensors, wearable sensors and sensors that detect contact (of an intruder) with

[1] Diwan S, Lee S, Sen S. Expectations of Filial Obligation and Their Impact on Preferences for Future Living Arrangements of Middle-Aged and Older Asian Indian Immigrants. *Journal of Cross-Cultural Gerontology*. 2010;26(1):55-69. doi:10.1007/s10823-010-9134-6.

[2] Liu T, Hao X, Zhang Z. Identifying community healthcare supports for the elderly and the factors affecting their ageing care model preference: evidence from three districts of Beijing. *BMC Health Services Research*. 2016;16(S7). doi:10.1186/s12913-016-1863-y.

[3] Granacher U, Gollhofer A, Hortobágyi T, Kressig R, Muehlbauer T. The Importance of Trunk Muscle Strength for Balance, Functional Performance, and Fall Prevention in Seniors: A Systematic Review. *Sports Medicine*. 2013;43(7):627-641. doi:10.1007/s40279-013-0041-1.

door or windows, embedded technology, face recognition systems, are highly appealing and make life easier and much safer [23, 24, 25, 26, 27].

Smart home technology has made people's life much easier. It is a boon for people with disabilities and the frail elderly population- as it augments safety, security, ease of self- management, and continuous monitoring of health. Sensors can detect serious events like a fall, unconsciousness, irregular heart-beat, fall in blood pressure, and immediately trigger an alarm and alert a family member or relative by sending a message [24, 25, 27].

5.2 Assisted Living

Assisted living is a promising option for the elderly and the disabled. In these facilities, caregivers may help with medications, preparing meals, following up with appointments, and help in regular activities. Some assisted living facilities provide healthcare in the same facility. Recreation and common dining facilities may be a part of assisted living [28].

6. Conclusion

Old age and disability present a varied challenges in front of the subject and the caregivers. Help from society is required- without that taking care of this vulnerable section of society is not possible. The care itself is a stressor for the caregiver as well. Introduction of various devices like sensors, video surveillance systems, wearable sensors, health monitoring devices, fall prevention devices, which have become a part of smart homes offer a great help. Assisted living concept is another great help that promises a hope for this vulnerable population, and to their caregivers.

7. References

[4] Fearing G, Sheppard C, McDonald L, Beaulieu M, Hitzig S. A systematic review on community-based interventions for elder abuse and neglect. *Journal of Elder Abuse & Neglect*. 2017. doi:10.1080/08946566.2017.1308286.

[5] Daly J, Merchant M, Jogerst G. Elder Abuse Research: A Systematic Review. *Journal of Elder Abuse & Neglect*. 2011;23(4):348-365. doi:10.1080/08946566.2011.608048.

[6] Kardile M, Peisah C. Elder abuse by abandonment in India: a novel community awareness and intervention strategy. *International Psychogeriatrics*. 2017;1-2. doi:10.1017/s1041610216002404.

[7] Chaganti R, Parimi N, Lang T et al. Bone mineral density and prevalent osteoarthritis of the hip in older men for the Osteoporotic Fractures in Men (MrOS)

Study Group. Osteoporosis International. 2010;21(8):1307-1316. doi:10.1007/s00198-009-1105-9.

[8] Center J. Fracture Burden: What Two and a Half Decades of Dubbo Osteoporosis Epidemiology Study Data Reveal About Clinical Outcomes of Osteoporosis. *Current Osteoporosis Reports*. 2017. doi:10.1007/s11914-017-0352-5.

[9] WHO | 10 facts on dementia. *Who.int*. 2015. Available at: <http://www.who.int/features/factfiles/dementia/en/>. Accessed March 28, 2017.

[10] Sachiyo Yoshida. A Global Report on Falls Prevention. WHO. 2017. Available at: <http://www.who.int/ageing/projects/1.Epidemiology%20of%20falls%20in%20older%20age.pdf>. Accessed March 28, 2017.

[11] Falls: Are People With Disabilities at Greater Risk?. *Idphstateil.us*. Available at: http://www.idph.state.il.us/idhp/idhp_Falls.htm. Accessed March 28, 2017.

[12] Berger NA, Savvides P, Koroukian SM, et al. Cancer in the Elderly. *Transactions of the American Clinical and Climatological Association*. 2006;117:147-156.

[13] Carro A, Kaski JC. Myocardial Infarction in the Elderly. *Aging and Disease*. 2011;2(2):116-137.

[14] AHA. CPR Facts and Stats. cpr.heart.org. Available at: http://cpr.heart.org/AHA/ECC/CPRAndECC/AboutCPR/firstAid/CPRFactsAndStats/UCM_475748_CPR-Facts-and-Stats.jsp. Accessed March 28, 2017.

[15] Mirza M, Strunets A, Shen W-K, Jahangir A. Mechanisms of Arrhythmias and Conduction Disorders in Older Adults. *Clinics in geriatric medicine*. 2012;28(4):555-573. doi:10.1016/j.cger.2012.08.005.

[16] Ovbiagele B, Nguyen-Huynh MN. Stroke Epidemiology: Advancing Our Understanding of Disease Mechanism and Therapy. *Neurotherapeutics*. 2011;8(3):319-329. doi:10.1007/s13311-011-0053-1.

[17] Stroke Facts | [cdc.gov](http://www.cdc.gov). [Cdcgov](http://www.cdc.gov). 2016. Available at: <https://www.cdc.gov/stroke/facts.htm>. Accessed March 28, 2017.

[18] Chronic rheumatic conditions. World Health Organization. 2017. Available at: <http://www.who.int/chp/topics/rheumatic/en/>. Accessed March 28, 2017.

[19] Arthritis-Related Statistics | Data and Statistics | Arthritis | CDC. [Cdcgov](http://www.cdc.gov). 2017. Available at: https://www.cdc.gov/arthritis/data_statistics/arthritis-related-stats.htm. Accessed March 28, 2017.

[20] Chronic respiratory diseases. www.who.int. Available at: http://www.who.int/gard/publications/chronic_respiratory_diseases.pdf. Accessed March 28, 2017.

[21] Caird F, Akhtar A. Chronic respiratory disease in the elderly: A population study. *Thorax*. 1972;27(6):764-768. doi:10.1136/thx.27.6.764.

[22] "Smart Home - Definition Of Smart Home In English | Oxford Dictionaries". *Oxford Dictionaries | English*. N.p., 2017. Web. 26 Mar. 2017.

[23] Scotto DiCarlo, Antonio, and Glen Cove. "SMART HOMES (Home Automation)". <https://ageing.ny.gov>. N.p., 2017. Web. 26 Mar. 2017.

[24] Demiris, George, and Brian Hensel. "Smart Homes" For Patients At The End Of Life". *Journal Of Housing For The Elderly* 23, no. 1-2 (2009): 106-115. doi:10.1080/02763890802665049.

[25] Roy, Patrice C., Abdenour Bouzouane, Sylvain Giroux, and Bruno Bouchard. "POSSIBILISTIC ACTIVITY RECOGNITION IN SMART HOMES FOR COGNITIVELY IMPAIRED PEOPLE". *Applied Artificial Intelligence* 25, no. 10 (2011): 883-926. doi:10.1080/08839514.2011.617248.

[26] Ai, Hong, and Tongliang Li. "A Smart Home System Based On Embedded Technology And Face Recognition Technology". *Intelligent Automation & Soft Computing*, 2016, 1-14. doi:10.1080/10798587.2016.1217634.

[27] Chen, Yie-Tarng, Yu-Ching Lin, and Wen-Hsien Fang. "A Video-Based Human Fall Detection System For Smart Homes". *Journal Of The Chinese Institute Of Engineers* 33, no. 5 (2010): 681-690. doi:10.1080/02533839.2010.9671657.

[28] Other long-term care choices | [Medicare.gov](https://www.medicare.gov). [Medicaregov](https://www.medicare.gov). 2017. Available at: <https://www.medicare.gov/what-medicare-covers/part-a/other-long-term-care-choices.html#collapse-4921>. Accessed March 28, 2017.

[29] O'Riordan S. Chronic kidney disease and older people--implications of the publication of the Part 2 of the National Service Framework for Renal Services. *Age and Ageing*. 2005;34(6):546-548. doi:10.1093/ageing/afi181.

[30] I Wallace J. Management of Diabetes in the Elderly. *Clinical Diabetes*. 1999;17(1). Available at: <http://journal.diabetes.org/clinicaldiabetes/v17n11999/Pg19.htm>. Accessed March 28, 2017.

[31] Diabetes in Older People. National Institute on Aging. 2017. Available at: <https://www.nia.nih.gov/health/publication/diabetes-older-people#managing>. Accessed March 28, 2017.

[32] Stokes GS. Management of hypertension in the elderly patient. *Clinical Interventions in Aging*. 2009;4:379-389.